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heretofore attributed to respiration, was confirmed. But it is clearly shown that the fixation of oxygen and the evolution of CO_2 have no relation to the life of the seed, and that a direct oxidation probably takes place with equal activity in live and dead seeds. Thus the gaseous exchanges of the integuments, compared with those of the decorticated seeds from which theycame, were frequently, weight for weight, very much larger. Further, these exchanges in the isolated integuments, compared with those of the entire seeds of the same species whose integuments are impermeable, are absolutely the same. Where the integument is permeable, however, the gaseous exchanges of the embryo are added to those of the integuments. None of these changes take place unless the air is moist and the protoplasm contains still a certain proportion of water.

BECQUEREL has also shown that no perceptible gaseous exchanges take place in the embryo when completely dehydrated, and that it can bear for a long time an atmosphere of carbonic acid, nitrogen, or a complete vacuum without losing its power to germinate. In fact, he is convinced that the loss of germinative power is dependent upon the changes permitted by the hygroscopicity of the seeds, and the only ones in which longevity is to be looked for are those with an impermeable integument.

Incidentally he discusses the longevity of seeds *in extenso*, and himself made experiments upon almost 500 species, belonging to 30 of the most important families of monocots and dicots, whose age was accurately known from the records of the ***Muséum d'Histoire Naturelle*** of Paris. Only four families had any viable seeds. Eighteen species of Leguminosae (87 to 28 years old), three species of Nelumbium (56 to 18 years), one Lavatera (64 years), and a Stachys (77 years) germinated.

BECQUEREL seems to have reduced the question to this dilemma: since there is no appreciable metabolism for as much as two years' time, in perfectly dry yet viable seeds, either their life-processes are wholly anaerobic, intracellular, and very slow, or life is completely suspended. He has begun an experiment of ten years' duration to determine whether the dried protoplasm is stable in a vacuum as perfect as can be obtained. He has inclosed in exhausted vials dry seeds of buckwheat and of wheat, with perforated integuments. These vials will be kept in darkness and will be examined with a spectroscope for gases every year, and at the end of ten years the seeds will be planted. This experiment promises to be a crucial one, if (as is to be expected) no gases are set free, and the seeds live. If it turns out otherwise, the choice between retarded life or suspended life for seeds will remain a speculative one.—C. R. B.

Apogamy and apospory in ferns.—HELENE WORONIN,[8] working in GOEBEL'S laboratory, has published the results of an experimental study on apogamy and apospory in ferns. The study included six species; *Trichomanes Kraussii*, *Pellaea flavens*, *P. nivea*, *P. tenera*, *Notochlaena Eckloniana*, and *N. sinuata.*

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[8] WORONIN, HELENE, Apogamie und Aposporie bei einigen Farnen. Flora **98**: 101–162. *figs. 72.* 1907.

Three species of Cheilanthes (*tomentosa*, *persica*, and *fragrans*) and five species of Notochlaena (*Marantae*, *squamosa*, *trichomanoides*, *vellaea*, and *lanuginosa*) were studied to induce apospory and apogamy, but without success, excepting one case of *N. Marantae*, which she says is a very rare one.

The paper first gives a description of *Trichomanes Kraussii* as to its general morphology, structure and development of antheridia, apogamy, and apospory. Then there follows an account of apogamy and apospory in three forms of Pellaea (*flavens*, *nivea*, and *tenera*) and two species of Notochlaena (*Eckloniana* and *sinuata*). Next there is given the result of apogamous and aposporous development in *Pellaea flavens* under culture both in darkness and on sandy soil. Last there is an account of the result of experiments on regeneration, using the two apogamous species of Pellaea (*nivea* and *flavens*), one apogamous form of Notochlaena (*Eckloniana*), and two normal species (*Gymnogramme farinifera* and *N. Marantae*).

From the detailed account a few points of interest may be summarized as follows: The prothallia of *Trichomanes Kraussii* consist of both filamentous and flattened parts; archegonia fail to develop; antheridia never attain maturity, apogamous embryos develop from the filamentous part, or from the margin or surface of the flattened part; at the outset the apogamous embryo consists of several cell layers which the author thinks to be homologous with the archegoniophore; from this structure a leaf process first appears, and then the stem apex develops independently of the former; the appearance of the root is delayed. Apospory is also induced in the same species by cultivating cuttings of leaves on loam; often the aposporous tendency prevails so far that antheridia are formed directly from the margin of the leaf.

The three forms of Pellaea (*flavens*, *nivea*, and *tenera*) and two species of Notochlaena (*Eckloniana* and *sinuata*) are all apogamous. No archegonia ever develop, and in *N. sinuata* no antheridia are ever formed. Generally speaking, in these five forms the apogamous structure is formed first as a leaf on the under surface of the sinus of the prothallium from the apical meristem. The stem apex then appears quite independent of the leaf; either between the leaf and prothallium or under the leaf; the root appears later.

In *Pellaea flavens*, grown in darkness, there is induced an apogamous structure, at first appearing as a leaf. After continued cultivation in darkness apospory was induced; from the arrested leaf grown under the sinus of the prothallium a new prothallium is formed which bears antheridia and develops also apogamous structures. It was not possible to distinguish the boundaries of the prothallial and apogamous structures. In sand cultures of *Pellaea flavens* there were found leaf buds on the arrested leaf grown under the sinus of the prothallia. Apogamous structures also developed from the same prothallium.

As a result of regeneration there appeared several interesting cases. When cut fragments of the sinus region of prothallia are put on the soil, further continuous development is checked, but new structures arise. From these structures often prothallia are formed again. The prothallia aposporously produced develop antheridia.—S. YAMANOUCHI.